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THE COST OF PRODUCING APPLES IN WENATCHEE VALLEY, WASH.

[A detailed study, made in 1914, of the current cost factors involved in the maintenance of orchards and the handling of the crop on 87 orchards.]

By G. H. Miller, *Assistant Agriculturist*, and S. M. Thomson, *Scientific Assistant*.

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INTRODUCTION.

This bulletin is the first of a series designed to meet the long-standing need for a careful study of apple orcharding in various parts of the United States which would give comparative and detailed information on the different methods of orchard management in vogue and the several factors which enter into the cost of apple production. This particular study was made during the summer and fall of 1914 in Wenatchee Valley, Chelan County, Washington, in territory tributary to the towns of Wenatchee, Monitor, and Cashmere. Complete and detailed data[1] were secured on the bearing apple orchards of 87 ranches,[2] and the figures presented represent conditions as they actually existed on the farms when surveyed in 1914.

[1] Unfortunately, few farmers keep accounts which would give the necessary information for a study of the cost of conducting various farm enterprises. However, ample experience in the Office of Farm Management has shown that although farmers may not have accurate records of their work, expenditures, and income, the average farmer does have in mind fairly accurate information on these points, and this information can be obtained from him by skillful questioning when the questions are stated in the terms in which the farmer thinks. The Office of Farm Management has therefore developed the method of studying cost of production by means of the farm survey, in which information is obtained from a large number of farmers by direct interviews. In many instances it has been possible to compare averages thus obtained with accurate records, and the results justify the conclusion that when the survey method is properly and skillfully used the information obtained by it is ordinarily as accurate as the results secured in carefully conducted field experiments. The survey method was used in obtaining the information contained in this bulletin.

[2] The word "ranch" is a local term for any farm, and the word "rancher" is used in the sense of farmer.

Note.—Acknowledgment is due to the Office of Horticultural and Pomological Investigations of the Bureau of Plant Industry for material assistance in the preparation of this bulletin.

SUMMARY OF RESULTS.

The salient facts concerning these 87 orchards brought out by this investigation, made in the summer and fall of 1914, are, in brief, as follows:

The average investment per farm surveyed is $20,974; the average investment per acre of bearing apples alone is $1,925. The equipment investment is high, being $444 per ranch, or $47 per acre, exclusive of stock. There is an average of two horses per farm, or 5.3 tillable acres per horse.

The total annual cost of production is $469.73 per acre, or $0.792 per box, f. o. b. Of this, labor-cost constituted $179.09 per acre, or $0.302 per box, and cash-cost, including interest on investment, $290.64 per acre, or $0.49 per box. This is the annual cost for the average orchard under clean cultural management. Where under alfalfa or clover management, this cost is reduced about $0.02 per box.[1]

Orchards average 6½ acres and 81 trees per acre. Trees average 11 years of age.

In the Wenatchee Valley proper, counting every bearing orchard, the leading 10 varieties in order of importance are: Winesap, Jonathan, Esopus, Rome Beauty, Stayman, Gano, Ben Davis, Yellow Newtown, Arkansas (Mammoth Black Twig), and Arkansas Black. On the basis of the number of young trees, 1 to 5 years of age, inclusive, the order is Winesap, Delicious, Jonathan, Rome Beauty, Stayman, Esopus, Winter Pearmain, Banana, Gano, and Yellow Newtown.

The yield per acre on the bearing orchards from which data were secured is 593 boxes, or 7.3 boxes per tree. This represents all yields on trees from 7 to 11 years, inclusive.

DESCRIPTION OF REGION.

The State of Washington (see fig. 1) is divided by the Cascade Mountains into two unequal and distinct parts, which results in a wide variation in climate and rainfall. West of the Cascades there is an annual rainfall sufficient for the growing of crops, while east of the mountains there are sections which have an annual precipitation of less than 8 inches, necessitating irrigation. The irrigated area is relatively small compared with the upland prairies, where the rainfall is sufficient for farming without irrigation. Fruit growing in eastern

[1] No account has here been taken of the depreciation of the orchards. If it is assumed that an orchard remains in full bearing for 30 years and then is removed, the rate of depreciation is 3⅓ per cent. This per cent of $1,925, the average value per acre of the orchards surveyed, is $64.17. That is, the depreciation is $64.17 per acre, or $0.1082 per box with the average yield of 593 boxes per acre. This is probably a maximum figure. It is probable that if the facts concerning the orchard depreciation were known they would add to the cost here something between $0.04 and $0.08 per box. This assumes, of course, that the orchard is in full bearing 30 years.

Washington is mainly confined to the irrigated sections. Naturally, with such a wide variation in climatic conditions, different areas have developed distinct types of farming.

The principal apple-producing areas of the State lie in the counties of Yakima, Chelan, Spokane, Kittitas, Walla Walla, and Asotin. There are extensive plantings of young trees in the county of Okanogan, while considerable acreage of apples is found in the counties of Douglas, Grant, Benton, and Klickitat. The most important in the production of apples, according to output, are the counties of Yakima, Chelan, and Spokane.

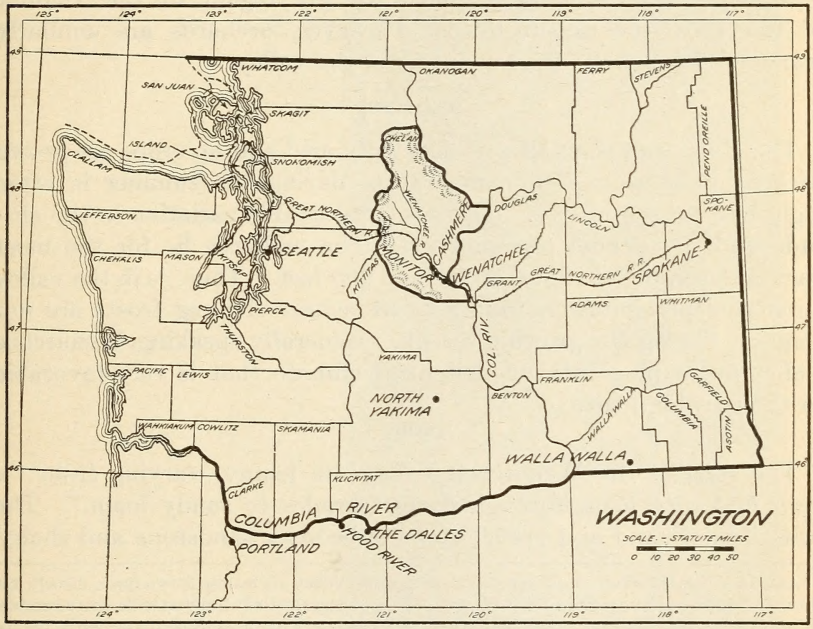


FIG. 1.—Outline map of State of Washington, showing location of Wenatchee Valley.

Chelan County, in which Wenatchee Valley is located, is in the north central portion of the State, having one of the main ranges of the Cascade Mountains on its western and northern boundaries, while the Columbia River flows on its eastern boundary, receiving the waters from several mountain streams which have their source in the Cascades. The principal apple-producing area lies in Wenatchee Valley in the vicinity of the towns of Wenatchee, Monitor, and Cashmere, and extends as far up the valley as Leavenworth. (See Pls. I, II, and III.) A very intensive region is in the semicircular area about the town of Wenatchee, which extends to the west for about 1½ to 2 miles with a gradual increase in elevation of from 700 feet at the railroad station to 850 where the foothills are approached, and to the north until it meets the Wenatchee River about a mile from its

entrance into the Columbia. From here the orchard area extends northwest along the narrow valley and adjacent slopes of the Wenatchee River to the town of Cashmere, a distance of about 12 miles. There is considerable variation of altitude throughout the valley, but most of the fruit is grown in an area from 700 to 1,000 feet in elevation.

Records were taken only in the vicinity of Wenatchee, Olds, Monitor, and Cashmere, and all data here presented refer only to orchard management in those sections, unless otherwise stated. Whenever Wenatchee Valley, or "the valley," is referred to in this bulletin, it has specific reference to the region in the vicinity of the above-mentioned towns. However, orchards are similarly managed throughout the remainder of the valley.

CLIMATE.

The climate of the valley is decidedly arid and no crops are grown without irrigation. The temperature during the summer is often high, but not oppressive. There is considerable variation in the altitude and the annual precipitation. The orchards lie for the most part between the altitudes of 700 and 900 feet. There is in the valley an annual precipitation from 8 to 15 inches. Killing frosts are not common during the growing season. Generally speaking, Wenatchee Valley has a pleasant and delightful climate that is very favorable to the growing fruit.

SOIL.

The soils of the Wenatchee Valley are loamy, varying from "a very fine silty loam through coarser grades to sandy loam." The subsoil is of sand and gravel and the bedrock sandstone and shale.[1]

[1] As far as origin is concerned, the soils of the Wenatchee Valley are mainly of two types, namely, the broad alluvial fans which are located at the foot of the steeper slopes and which appear to the best advantage in the sweeping semicircle which contains the town of Wenatchee with the neighboring orchards. At the mouths of each of the several canyons these fans have been formed. The canyons have been carved mainly in the upturned sandstones and clays which come originally from the granite rocks. Above the town of Wenatchee, continuing up the valley, while there are occasional fans the river terraces are much more conspicuous. The terraces are composed at the base of glacial bowlders and gravels. Upon these one will find river gravels and sands. The soil to a depth of several feet, which has been superimposed upon the gravel and sand, is largely of eolian origin and hence is of a very fine grain and retains the moisture very readily.

In general, one might say that throughout the Wenatchee Valley the bedrock is represented by upturned layers of sandstones and shales of lacustrine origin. Next comes a subsoil which is very coarse at the base, but grading upward into gravels and sands of river origin. The top soil, varying from a few inches to a hundred feet, is of very fine grain and in the main has been carried to its present position by the persistent winds which come out of the mountains to the westward. The soil is loamy in character and varies from a fine silty loam through coarser grades to a sandy loam. Rarely is it composed mainly of sand, but in general it has the right physical properties to retain the moisture with readiness. Chemically, it is good in lime, iron, and potash, but is low in nitrogen. Cover crops which will yield nitrates have very greatly increased the yield of soil and such crops have come to be absolutely necessary in the older orchards.—Henry Landes, State geologist, Washington.

GENERAL VIEW OF THE MOST INTENSIVE APPLE-PRODUCING REGION OF THE WENATCHEE VALLEY, NOT FAR FROM WENATCHEE. CONFLUENCE OF WENATCHEE AND COLUMBIA RIVERS IN THE DISTANCE.

VIEW OF THE MOST INTENSIVE APPLE-PRODUCING AREA IN THE VICINITY OF CASHMERE.

VIEW LOOKING WEST ACROSS THE WENATCHEE RIVER, SHOWING APPLE ORCHARDS ON THE RIVER FLATS AND ON THE SLOPE NEAR MONITOR.

VIEW OF THE HIGHLINE IRRIGATION CANAL ABOVE CASHMERE, ON THE EAST SIDE OF WENATCHEE VALLEY.

AGRICULTURE OF THE REGION.

Wenatchee Valley has a highly specialized type of agriculture. It is a region of intensive fruit growing, confined very largely to the apple. The ranches, in general, are small, those included in this investigation averaging 11.4 acres in size, of which 10.5 acres are tillable. Of the tillable land, 6.5 acres were in bearing apples, 0.72 acre in other fruits, and 0.58 acre in other crops. However, there are a few large ranches devoted to fruit growing, some of them embracing several hundred acres each. The region is not adapted to an extensive type of agriculture. The two predominant limiting factors are the high price of land and the small area of irrigable land. Considerable alfalfa is grown in the valley, but it is largely grown in young orchards, and at present much of it is being grown in the bearing orchards. The soil and climate are adapted to a great variety of crops, but appear especially adapted to fruit.

DEVELOPMENT OF THE FRUIT INDUSTRY.

The first settlement in the valley was made in 1863 at Cashmere, then named Mission, by Father Grassi, who later diverted the waters of Mission Creek to water a small garden near the mission.

The first fruit trees were set out by the Miller brothers, some reports giving the date as 1873, others 1876. The first irrigation ditch in the valley was established by the same men in 1883, and still exists as the Miller ditch.

Practically the entire Wenatchee Valley was a barren waste until 1896, when the Gunn ditch was built, covering 600 acres of irrigable land. During the same year the North Wenatchee Canal Co. was formed and the ditch built covering the Warner Flat near Cashmere. This ditch was taken over by the Highline in 1902, and now forms a part of the latter system.

In 1901 W. T. Clark, of North Yakima, was interested in the prospects of developing the irrigation system in the Wenatchee Valley and soon thereafter took over the organization of the Highline (Wenatchee Highline Canal Co.). The ditch as built covered 9,000 acres of orchard land and was completed to Wenatchee in October, 1903. (See Pl. IV.) This was the real beginning of the orchard development in the Wenatchee Valley. Development continued until in 1913 there were more than 20,000 acres of irrigable land under the different ditches.

The planting of fruit trees was more or less correlated with the development of irrigation. Table I gives the total apple acreage in north central Washington and the acreage in the Wenatchee Valley.

TABLE I.—*Total apple acreage and number of trees in north central Washington and in Wenatchee Valley.*[1]

North central Washington:	
Total apple acreage	41,711
Total number of apple trees	2,678,172
Number of apple trees, 10 years and over	227,695
Wenatchee Valley:	
Total apple acreage	11,445
Total number of apple trees	736,455
Number of apple trees, 10 years and over	164,927

The growth and importance of the apple industry in north central Washington is also shown by the increase in the number of cars of apples shipped during the 10 years 1905–1914 (Table II).

TABLE II.—*Number of cars of apples shipped from north central Washington from 1905 to 1914, inclusive.*

Direction of shipments.	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914
Cars east	254	222	508	995	492	1,851	1,201	3,413	3,546	5,913
Cars west	257	202	150	274	118	343	507	887	910	980

METHOD OF SURVEY.

In making a study of this kind it is highly important that average conditions of the district be obtained. At the beginning of this particular investigation many orchardists in the intensive commercial apple-producing regions about Wenatchee, Olds, Monitor, and Cashmere were visited. In choosing the ranches from which records were obtained no effort was made to select the seemingly better class of orchardists. In order to make the data uniformly comparable, it was imperative that the orchards chosen should contain trees of the same bearing age; that the trees should be uniform and typical of the region; that the orchard should contain only apple trees and not be interset with peaches, pears, plums, or other fruit trees; that intertillable crops other than cover crops should not be present; that the orchard should be managed as the representative commercial apple orchard of the valley; that if the trees were top-worked such trees should have been worked over to the present variety for at least five producing seasons, and that the manager, renter, or person doing the work should have had supervision of the orchard for at least five years so as to be conversant and thoroughly acquainted with the methods of management, conditions, and yields of the orchard for such a period.

Where conditions did not conform to these limitations, as a rule data were not taken. Where any discrepancy arose after data had

[1] The north central Washington tree census for 1915—State department of agriculture.

been taken, the records were not used in the final compilations. After eliminating the discrepancies there were 87 complete records which fully met the specifications.

INVESTMENTS.

Estimates of the amount of capital invested were obtained from each orchardist. This estimated value, in the majority of cases, was the amount the rancher paid for the place, plus the value of such improvements as he had made since the purchase. There were a few ranchers who had owned their property before local land values had advanced to any great extent. Most of these men based their estimates on prices that at some time or other had been offered for their holdings. These estimates were generally found to approximate closely prices that had been paid for adjacent land in bona fide sales. The values may seem high, but they represent actually what the majority of men visited in this investigation either had paid or had been offered for their orchards. In all probability a lower valuation would be given now (1916).

As figured from the estimates of the 87 owners, the average total investment per ranch is $20,974, while the average investment in bearing apple orchards per ranch is $12,250. By giving each of the 87 orchards the same weight, that is, taking the estimated value of a single acre of bearing apples as representative of each orchard, there is an estimated average investment of $1,925 per acre for bearing apples. The annual interest charge on this alone amounts to $154 per acre, at 8 per cent. (See Table III.)

TABLE III.—*Average investment and average acreage per ranch (87 ranches) in Wenatchee Valley in 1914.*

Average investment per ranch	$20,974.00
Average investment per acre	$2,026.00
Average size of ranch (acres)	11.4
Average size of bearing apple orchard (acres)	6.5
Average value per acre of bearing apple orchard	$1,925.00

COMMERCIAL VARIETIES GROWN.

Over 60 varieties of apples are grown in Wenatchee Valley. In some of the older orchards are found the Baldwin, Rhode Island Greening, Northern Spy, Ben Davis, York Imperial, and other varieties which are of little commercial importance to the orchardists of the valley. These varieties were planted by the earlier pioneers.

The older commercial orchards of the valley to-day contain for the most part varieties such as Winesap, Jonathan, Esopus, and Rome Beauty. The Winesap, Jonathan, Stayman, Rome Beauty, together

with the Delicious, have been planted to a considerable extent within the last five years. Table IV gives the first 10 varieties, 10 years or over, in order of their importance, and the first 10 varieties between 1 and 5 years of age in order of their importance, according to the number of trees planted.

The trees in the valley were originally planted on the square, diamond, or quincunx plan. The distances set varied from 20 by 20 feet to 28 by 28 feet. The majority were set from 20 to 22 feet apart on these various systems.

TABLE IV.—*Varieties of apples in order of number of trees planted.* (*Wenatchee Valley.*[1])

Trees 10 years of age or over.		Trees between 1 and 5 years of age.	
Variety.	Number.	Variety.	Number.
1. Winesap	28,188	1. Winesap	193,940
2. Jonathan	25,142	2. Delicious	39,597
3. Esopus	17,106	3. Jonathan	25,131
4. Rome Beauty	15,852	4. Rome Beauty	21,126
5. Stayman	13,868	5. Stayman	19,491
6. Black Ben	9,896	6. Esopus	9,851
7. Ben Davis	7,633	7. Winter Pearmain	4,030
8. Yellow Newtown	7,533	8. Banana	3,408
9. Black Twig	5,606	9. Black Ben	1,939
10. Arkansas Black	5,600	10. Yellow Newtown	1,226

[1] North central Washington tree census for 1915. Trees planted in the vicinity of Wenatchee, Olds, Monitor, and Cashmere.

AGE AT WHICH APPLE TREES BEGIN TO BEAR.

Apple trees in Wenatchee Valley begin to bear fruit at an early age. A number of estimates were obtained relative to the age that different varieties would bear a box of marketable apples per tree. There was some variation, owing to the many factors which were considered. It was, however, not difficult to obtain this information, for many orchardists had grown their trees or had come into possession of them prior to the time they began to bear. There is a considerable difference of opinion as to the exact order in which the different varieties should be placed, but most orchardists agree that the majority of the important commercial varieties under average conditions in Wenatchee Valley will bear a box of marketable apples per tree prior to 7 years of age. Table V gives the order, determined as nearly as possible, in which they come into bearing.

TABLE V.—*Ages within which commercial varieties may be expected to bear a box or more of marketable apples.*

5 to 7 years:	5 to 7 years—Continued.	7 to 8 years:
1. King David.	8. Winter Pearmain.	14. Esopus.
2. Missouri.	9. Rome Beauty.	15. Yellow Newtown.
3. Jonathan.	10. Black Ben.	16. Arkansas Black.
4. Grimes.	11. Ben Davis.	
5. Banana.	12. Delicious.	
6. Stayman.	13. Arkansas.	
7. Winesap.		

YIELDS.

Estimates of yields were obtained for a period approximating five years. In presenting data of this sort it is highly important that the yield should be considered over as long a period as possible in order to obtain a fair average for a district. Where very few orchards are over 11 years of age, as was the case in the valley at the time of this study, it is impossible to obtain a sufficient number of comparable yields for any period other than that represented by trees from 7 to 11 years of age, inclusive. The average estimate of all yields from orchards between these ages was obtained and considered as a fair average yield for the valley. In computing this average, each age is given the same weight, regardless of the year in which a given orchard might be a certain age. For example, yields on orchards at the time they were 7, 8, 9, 10, and 11 years were averaged and this average was used as the average yield for the valley. In this way 271 estimates were considered. Forty-seven were from orchards 7 years of age; 60 from orchards 8 years of age; 67, 9 years of age; 59, 10 years of age; and 38, 11 years of age. These estimates extended over a period of 6 years; 8 of them in 1909, 34 in 1910, 61 in 1911, 71 in 1912, 75 in 1913, and 22 in 1914. Considering the factors stated above, the average yield per acre of apple orchards in Wenatchee Valley with 81 trees per acre was 593 packed boxes.

There is a tendency in some apple-producing regions toward alternate bearing, and many times frosts, winds, insect pests, and diseases have an effect on the annual yield of the district, but by taking yields over a period of years on trees which are representative of a district it is possible to obtain an average yield which is accurate enough to furnish a basis for such a study as is here presented.

There is no appreciable difference in yield between clean cultivated and alfalfa orchards, nor could this be expected, since so few orchardists had followed the cover-crop management for any considerable period.

There is considerable difference in yield between different varieties, and no doubt there is a difference in the number of boxes of extra fancy, fancy, and choice grades which are packed from an acre of the different varieties. But no account was taken of this, for it was the purpose of the investigation merely to arrive at the average annual cost of producing apples, grown in well-managed commercial apple orchards of the valley.

LABOR.

The average size fruit ranch in the Wenatchee district is such that most of the labor, except at harvest time, may be done by the ranchers or by members of their families. But little outside labor is hired. Labor when employed by the month is paid from $35 to $50, varying

with the privileges which are given. The following rates were paid labor for various operations:

Pruning	$3.00 to $3.50 per day.
Packers	.06 per box.
Packing and sorting	.07 per box.
Thinning	2.50 per day.
Man, team, and sprayer	1.50 per hour.
Picking	2.50 per day.
Man and team	5.50 per day.

Expert pruners receive from $3 to $3.50 per day, but as the majority of ranchers did this work themselves and were not considered as expert labor in the same sense as a man who makes a business of contract pruning, the pruning labor was figured at the regular rate of $0.25 per hour.

The rate of $1.50 per hour for sprayer, man, and team is high, but that was the rate paid by many of the growers who hired their spraying. This did not include the material used.

ITEMS CONSIDERED IN COST OF PRODUCTION.

In considering in detail the cost of producing apples on the farms studied the following classification of costs will be observed in this discussion:[1]

Maintenance costs:
- Manuring.
- Cultivation.
- Pruning.
- Brush handling.
- Irrigation.
- Thinning.
- Propping.
- Spraying.
- Cover crop.
- Miscellaneous labor.

Handling costs:
- Hauling box shooks.
- Making boxes.

Handling costs—Contd.
- Hauling empties to and from orchard.
- Hauling full boxes.
- Foreman charge.
- Picking.
- Sorting, packing.
- Nailing and stamping.
- Labeling.

Material costs:
- Box shook.
- Nails.
- Paper.
- Label.

Material costs—Contd.
- Lime-sulphur.
- Lead-arsenate.
- Manure.
- Gasoline and oil.

Fixed costs:
- Taxes.
- Water tax.
- Insurance.
- Interest on investment.
- Equipment charge.
- Packing-house charge.

ORCHARD MANAGEMENT.

In the early days of orchard planting it was the object of the orchardist to obtain a vigorous annual tree growth. The soil at that time contained enough plant food to give the desired results, with the aid of sufficient irrigation water. The most intensive methods of cultivation were followed; scarcely a weed was allowed to remain in the orchards. This practice continued until the trees had borne a few crops, when it became apparent that more humus-forming material was necessary if the growth and productiveness of the orchards were to be maintained.

[1] No account is here taken of association or other handling charges such as storage and insurance. The total costs represent all charges up to and including delivery at an association or shipping point.

This condition led to the introduction of alfalfa, clover, and vetch as a shade or mulch crop, until to-day there are nearly 4,000 acres in alfalfa, 500 acres in clover, and 500 acres in vetch in the orchards of north central Washington. Obviously, with the introduction of these crops the method of cultural management gradually changed. At the time of this investigation this change was being made, but the new method had not been in vogue long enough, when records were secured, for the most reliable results. Nevertheless the subject of the management of such orchards is discussed briefly so as to show a comparison of the different methods and the possibility of decreasing the cost of production of the apple where the yields remain the same. There are factors which may tend to show the impracticability of

FIG. 2.—A 5-year-old Jonathan orchard near Wenatchee in which clean cultivation has always been practiced.

introducing a mulch crop, but at present it seems that yields can be kept normal by a resort to this expedient, and that at the same time the amount of labor involved in the care of the orchard can be decreased.

However, this bulletin deals primarily with the cost of producing apples in the bearing orchards studied where clean cultivation is practiced.

CLEAN CULTIVATION.

It is the common practice in all irrigated regions to begin the seasonal preparation of the soil by plowing or disking in the fall or spring. It is the purpose of these operations to put the soil in a condition to facilitate the use of the spring-tooth and the spike-tooth harrow, the cultivator, and the float. It is usually possible to begin the cultural work on the soil before the middle of April. (See fig. 2.)

Of the 57 ranchers who practiced clean cultivation, 28 began the seasonal preparation of the soil by the use of the plow, 25 by the disk harrow, 3 by the cultivator, and 1 by the spike-tooth harrow. Of the 28 who plowed, 15 did so in the fall and 13 in the spring. Not all of these orchardists, however, plow every year. Nineteen plow every year, 8 every two years, and 1 every three years.

Following the plowing or disking, cultivations are given previous to the first irrigation. All orchardists who follow any method of clean cultivation do some cultivating previous to the first irrigation. Following these first cultivations, which are usually between April 1 and May 15, the orchard is furrowed preparatory to the first irrigation. Furrowing is locally known as "creasing." Cultivations are usually given after irrigations until the middle of the summer, or until the weight of the fruit bears the limbs down so that further cultivation is impracticable. If at any time there is a rain heavy enough to pack the soil, a cultivation is usually given. Not all orchardists, however, cultivate after each irrigation. (See Table VI.)

TABLE VI.—*Analysis of operations in clean cultivation.*

Operation.	Orchardists who perform each operation.		Man.		Horse.
	Number.	Per cent of total.	Hours per acre.	Per cent of total time.	Hours per acre.
Plowing	28	49.12	2.91		5.35
Cultivation:					
Total			21.36	100.00	38.98
Before first irrigation	57	100.00	11.96	55.99	22.26
Following first irrigation	52	91.23	4.69	21.96	8.57
Following second irrigation	36	63.16	3.25	15.22	5.58
Following third irrigation	18	31.58	1.28	5.99	2.30
Following fourth irrigation	3	3.51	.13	.61	.18
Following fifth irrigation	1	1.76	.05	.23	.09
Creasing:					
Total			4.24		6.48
Before first irrigation			1.51		2.34
Before second irrigation			1.39		2.14
Before third irrigation			.93		1.34
Before fourth irrigation			.35		.55
Before fifth irrigation			.04		.06
Before sixth irrigation			.02		.05

There appears to be no particular sequence in the use of the cultural implements. The exact method by which desirable conditions of tilth are secured is in part dependent upon the local soil and climate and in part upon the individual conception of the orchardist. There enters here, however, the proper study of the soil with which each grower has to deal, the behavior of the trees, and the condition of the fruit. Early plowing and maintenance of a good soil mulch are of great advantage in retaining the moisture in the soil during the growing season. (See Table VII.)

TABLE VII.—*Number of times various implements are used in the 57 clean-cultivated orchards.*

When used.	Plow.	Disk harrow.	Spring-tooth harrow.	Spike-tooth harrow.	Cultivator.	Float.
Previous to first irrigation	28	39	66	42	25	22
Following first irrigation	.....	2	36	14	24	8
Following second irrigation	.....	.....	24	12	14	5
Following third irrigation	.....	.....	11	5	6	2
Following fourth irrigation	.....	.....	1	.....	.....	.....
Following fifth irrigation	.....	.....	1	.....	.....	.....

There are many factors which may affect the time required for the various operations. Among these are number in crew, time of year, topography, type and condition of soil, kind of cover crop, if any, depth to which implements are worked, and kind and size of implement used. (See Table VIII.)

TABLE VIII.—*Average time required and cost per acre for various cultural operations on farms studied in Wenatchee Valley.*

Implement.	Width of implement.	Number of—		Acres per 10 hours.	Cost per acre.
		Men.	Horses.		
Plow	12 inches	1	2	1.49	$3.679
Disk harrow	5 feet	1	2	4.46	1.232
Spring-tooth harrow	6 feet	1	2	5.90	.932
Spike-tooth harrow	7 feet	1	2	9.60	.572
Cultivator	.....	1	2	6.30	.873
Float	10 to 14 feet	1	2	7.50	.733

Considering all records, regardless of number in crew, or kind or size of implement used, a total of 21.36 man-hours and 38.98 horse-hours per acre was chargeable for all cultivation, exclusive of plowing and creasing, or a per acre cost of $11.19. Considering all cultural operations, including plowing and creasing, there was a total charge of $14.75 per acre.

MANURING.

In the early days of orchard planting throughout the valley, the trees made a luxuriant growth, and at the time that they came into bearing gave a good crop, which did not seem to affect the physical condition of the tree the year following. It was the impression that this virgin soil contained an abundance of plant food, so that the need of returning fertility to the soil was not felt. Later, however, this valley gained some valuable lessons from the experience of other northwestern sections, and many orchardists began to apply manure. Inasmuch as the average ranch throughout the valley is small, the grower usually having only one or two horses and in some instances a cow, not enough manure is produced to make a thorough application each year to the entire orchard.

Of the 87 ranchers from whom records were taken, 49, or 56 per cent of the total number, applied each year the little manure produced on the place. This amounted to about 4 tons per acre, which was usually applied directly from the wagon by one man with two horses, covering 1.44 acres in 10 hours. This is not efficient work as compared with results on farms where large quantities of manure are handled annually. This inefficiency may be due in part to difficulty of spreading manure in orchards planted very closely together, but it can be more generally attributed to the fact that the manure is not applied during a rush season, hence the grower takes his time. Where all records are considered, regardless of crew or method of handling, there is an average labor cost for applying manure of $2.27 per acre.

PRUNING.

Pruning is an annual practice of all orchardists in the valley. It is usually done during the dormant condition of the tree, in the late fall or early spring. However, some men practice summer pruning; if so, it is generally done as a supplement to winter pruning.

There are many factors that influence the number of trees that may be pruned in 10 hours. The more important of these are the age of the tree, the variety and habit of growth, the height and shape of the tree, the distance apart, the efficiency and skill of the pruner, the previous method of pruning, and the amount of work to be done.

Considering the average number of trees per acre as 81 and 19.3 trees as the average number of trees pruned per 10-hour day, there will be an annual charge of 40.31 man-hours per acre, or a cost of $10.08.

HAULING BRUSH.

In connection with the annual pruning of the orchard, the disposition of the brush takes more or less time. This operation is usually done either by two men and two horses or by one man and two horses. (See Table IX.)

The brush is often gathered in the center of the tree rows at the time of pruning or after pruning. This makes it much easier to handle the brush quickly. As a general rule, however, a crew of two men and two horses with a wagon will pass between the tree rows, the men gathering the brush on either side of the wagon, and hauling it to some convenient place and burning it, either at once or later in the season when the brush has dried. The trees are so young and the pruning generally has been so well done that there is a very small amount of large wood, so that practically very little trimming up of the pruned wood is necessary.

Considering the number of man-hours and horse-hours required for this operation, and assuming that the amount of brush was the same in each instance, it appears from Table IX that the most econom-

ical way to remove brush is by the 2-men and 1-horse crew. However, as there are only five records of this method, this result can not be taken as conclusive.

TABLE IX.—*Average number of acres of brush removed by different crews in 10 hours.*

Number of records.	Number of—		Acres per 10 hours.	Cost per acre.
	Men.	Horses.		
43	2	2	1.56	$5.12
25	1	2	.93	5.90
9	1	1	.90	4.43
5	2	1	1.50	4.34

Considering all records, there is an annual charge of 11.86 man-hours and 14.46 horse-hours per acre for handling the brush, at a cost of $5.14 per acre.

FURROWING.

Furrowing, or "creasing," is a practice of making small ditches for distributing water for irrigation. The cultivator and the shovel plow are the implements most commonly used for this operation. In clean cultivation furrows are made just prior to the time of irrigation. All orchardists furrowed once; 91 per cent, twice; 63 per cent, three times; 31½ per cent, four times; and 3½ per cent, five times. Most alfalfa orchardists furrowed but once, just after the spring cultivation. A few of the alfalfa orchardists made a practice of cleaning out the furrows following the harvesting of alfalfa.

Usually a 6-foot cultivator with three shovels attached, one at either end and one in the middle, is used for making furrows. Four to six furrows, varying in depth from 4 to 6 inches, and approximately 3 feet apart, are usually made between tree rows.

A crew of one man and two horses with the 6-foot cultivator, making the usual number of furrows—six between rows—covered 8.3 acres per day, at a labor cost of 66.3 cents per acre. A crew of one man and one horse with the shovel plow, making the usual number of furrows—five between rows—covered 5.15 acres per day, at a labor cost of 77.6 cents per acre. (See Table X.)

TABLE X.—*Average time and cost of making furrows in clean-cultivated orchards with the 6-foot cultivator or the shovel plow.*

Implement.	Number of—		Acres per 10 hours.	Man-hours per acre.	Horse-hours per acre.	Cost per acre.
	Men.	Horses.				
6-foot cultivator	1	2	8.3	1.204	2.408	$0.663
Shovel plow	1	1	5.15	1.94	1.94	.776

In making furrows in alfalfa orchards the shovel plow is most frequently used. For the 30 records under consideration, 19 used the shovel plow, 11 with 1 horse and 7 with 2 horses; 8 used the cultivator, and 3 used miscellaneous tools. A crew of 1 man and 1 horse, using the shovel plow, making the usual number of furrows—five between rows—covered 5.02 acres per day, at a cost of 79.7 cents per acre; while a crew of 1 man and 2 horses with the shovel plow averaged 4.9 acres in 10 hours, at a cost of $1.12 per acre. Where the 6-foot cultivator was used, 7.57 acres, on an average, were covered per day at a cost of 72.7 cents per acre. (See Table XI.)

TABLE XI.—*Average time and cost of making furrows in cover-crop orchards with the 6-foot cultivator or the shovel plow.*

Implement.	Number of—		Acres per 10 hours.	Man-hours per acre.	Horse-hours per acre.	Cost per acre.
	Men.	Horses.				
6-foot cultivator	1	2	7.57	1.32	2.64	$0.727
Shovel plow	1	1	5.02	1.99	1.99	.797
Do	1	2	4.90	2.06	4.12	1.120

IRRIGATION.

In the Wenatchee Valley the supply of water for irrigation purposes is obtained principally from the Wenatchee River and its tributaries. It is distributed at altitudes a little above the location of the orchards through several irrigation ditches, thence to the orchards through laterals. These laterals may be open ditches, wooden flumes, or pipes. The water is delivered from the laterals to the farm. At the point of delivery on the farm, the water received is distributed either into earth head ditches, small wooden flumes, or pipes, and from these it is distributed by means of furrows throughout the orchard. Along the earth head ditches small wooden spouts are placed at intervals to regulate the flow of water into the furrows. The wooden flumes receiving the water from the laterals are usually about 6 to 8 inches in width at the bottom, having sides 6 to 8 inches in height, with auger holes at regular intervals through which the water passes into furrows. Small metal slides or pieces of lath are placed over the auger holes for the purpose of regulating the amount of water passing into the furrows. Where the water is piped into the orchard, there are usually placed at points opposite each tree row small standpipes with garden valves, which deliver the water directly into the furrows.

In regions where the supply of water is limited, the furrow system seems to be the most satisfactory means of distributing the water. This is practically the universal method for irrigating orchards throughout the Northwest.

The operation of turning the water on the land is termed a "set." It may be necessary if the head of water is small to make several changes or "sets" before the entire area is irrigated. This is usually the case, especially where the orchard tracts are large. For this reason the orchardist turns the whole of the head into a few furrows and allows it to run from 12 to 72 hours, varying with the type and condition of the soil. The water is allowed to run until, by a slow lateral movement, it has thoroughly saturated the soil between the furrows. As a rule the rancher judges merely by the surface conditions of the soil as to when sufficient saturation has taken place. When he finds that the area has become well saturated, he turns the water into another portion of the orchard, and so on until the entire area is irrigated.

Many factors affect the time and labor of irrigation. The principal ones are: Water head; contour of land; method of delivery, whether open ditch, flume, pipe, or faucet; number, length, and depth of furrows; kind of soil; physical condition of soil; cultural method; atmospheric conditions; gophers.

On the average, four irrigations are made in Wenatchee Valley annually. The first irrigation is usually made between the 1st and 15th of May, the second between the 1st and 15th of June, the third between the 1st and 15th of July, and the fourth between the 1st and 15th of August. In some instances irrigations are made as early as April and as late as the middle or latter part of September. There are a few orchardists who make as many as nine irrigations.

There is practically no difference in the time required for irrigating the alfalfa and the clean cultivated orchards. On those farms studied in the valley, the average number of man-hours per season necessary to irrigate an acre of clean-cultivated orchard was 34.37, making a labor cost of $8.59, while the average time necessary to irrigate 1 acre of an orchard in alfalfa was 35.66 man-hours, making a labor cost of $8.92.

THINNING.

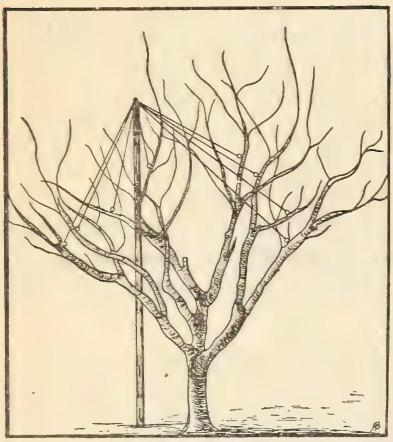
Practically every orchardist in the valley thins his fruit. Thinning is very important, and the quality of the fruit which matures depends to a great extent upon the amount of thinning done. There are some varieties which require more thinning than others. The Missouri, Wagener, Grimes, Yellow Newtown, and King David are varieties which perhaps demand more thinning than any others in order to produce a fruit of marketable size. This thinning is generally done after what is known as the "June drop," when the apples begin to approach the size of a walnut. Many times it is impossible to get all the thinning done at this time, other operations interfering.

Many men thin two or three times during the season. The size and age of the tree have considerable bearing on the length of time required for this operation.

There are two methods of thinning used in the valley, with shears and by hand. The length of time required for each of these methods is affected not only by the efficiency and experience of the operator

A. Center-ring-and-wire prop.

B. Cross-wire prop.



C. Center-pole-and-wire prop.

D. Single-pole prop.

FIG. 3.—Four methods of propping apple trees in Wenatchee Valley. The single-pole prop is most commonly used.

but by the density of the foliage and the equipment which it may be necessary to use on account of the size of the tree.

In some seasons it is of course necessary to thin more heavily than in other seasons. When a large crop is expected heavy pruning is done the winter before, and in that way some of the work of thinning is obviated. Under normal conditions the trees of the valley usually bear a heavy crop every other year.

The factors which appreciably affect the time required for thinning may be summed up as number of trees per acre, variety, size of tree, age, method of pruning adopted, water supply, soil condition, method of thinning (by shears or by hand), density of foliage, equipment, hail, tendency to alternate bearing, and the quantity of fruit removed. Considering all records, the average time per acre required for this operation was 53.29 man-hours at a cost of $13.32.

PROPPING.

The regularity of the apple crop in the valley necessitates the practice of propping annually. This is done any time throughout the growing season when the weight of the fruit bears the limbs down so

FIG. 4.—The center-pole-and-wire method of propping. This tree is a 3-year Winesap graft on a 5-year-old Wagener stock.

that there is danger of their breaking. Four methods of propping are used by the orchardists: The center-ring-and-wire, the cross-wire, the center-pole-and-wire, and the single-pole prop.

In the center-ring-and-wire method (A, fig. 3) screw eyes are placed in the main limbs at some distance above the crotch of the tree. Wires are attached to the screw eyes and brought to a ring placed approximately in the center of the tree. This holds the tree in shape and prevents the breaking of the limbs at the time when the crop is on.

In the cross-wire method (B, fig. 3) screw eyes are placed in the main limbs at some distance above the crotch. From each screw eye a wire extends and is attached to a limb opposite or nearly so. This answers the same purpose as the former method.

In the center-pole-and-wire method (C, fig. 3) screw eyes are placed in the main limbs, to which are attached long strands of wire. At

the end of each strand is a loop which is placed over a nail driven in the end of a pole. This pole is raised to a position nearly parallel to the trunk of the tree and set. This draws the wires tight, holds the tree in shape, and prevents the limbs from breaking. (See also fig. 4.)

The single-pole prop method (D, fig. 3) is most common. This single pole usually consists of a 1 by 2 inch or 1 by 4 inch pine strip varying in length as conditions demand. The 8 to 12 foot lengths are most commonly used. These props are usually sharpened at one end so as to make it easy to place them in the ground. The end which is to hold the limb is V-notched or small lath strips are tacked on each side of the prop, practically forming a notch.

There are three methods of single-pole propping in common use. First, one crew may haul and scatter the props through the orchard while another crew sets them up (A, Table XII); second, a crew may haul the props out and set them as they go (B, Table XII); third, the props may be hauled out and set up as needed (C, Table XII). Sometimes an orchardist may carry out and set them as needed.

The time required for this operation is no doubt more variable than that for any other operation.

TABLE XII.—*Average time per acre required on farms studied for propping with the single-pole prop used in three ways.*

Operations.	Number of—		Acres per 10 hours.	Per acre.		
	Men.	Horses.		Man-hours.	Horse-hours.	Cost.
Method A:						
Hauling to orchard	1	2	4.56	2.19	4.38	$1.205
Setting up	1		.596	16.81		4.203
Hauling from orchard	1	2	4.60	2.17	4.34	1.194
Total				21.17	8.72	6.602
Method B:						
Hauling to orchard	1	1	5.58	1.79	1.79	.716
Setting up	1		.694	14.40		3.60
Hauling from orchard	1	1	5.58	1.79	1.79	.716
Total				17.98	3.58	5.032
Method C:						
Hauling out and propping	1	2	.878	11.39	22.78	6.265
Hauling from orchard	1	2	4.42	2.45	4.90	1.348
Total				13.84	27.68	7.613

All records considered, there is an acre charge of $6.36 for propping.

SPRAYING.

All orchardists in the valley spray annually, realizing the vital importance of a thorough and systematic application of spray materials to insure the production of marketable apples.[1]

[1] Since the investigation, other diseases and insects have caused some change in the spray calendar in the Wenatchee Valley.

The spray outfit usually consists of a 2½ to 3½ horsepower gasoline engine and a 150 to 250 gallon tank mounted on a truck. Two 50-foot lengths of spraying hose, with 8 to 10 foot bamboo extensions and nozzle attachments, complete the outfit. A single nozzle is most commonly used with each hose. Only a few of the outfits carry a spray tower. Not every orchardist owns an outfit. Some own a share in an outfit, while others hire their spraying done. When the spraying is hired, a man with team and sprayer receives $1.50 per hour, the orchardist furnishing the material.

The first application of spray is made when the trees are dormant, the second when 75 to 90 per cent of the petals have fallen, the third two to three weeks following the second, and the fourth during the latter part of August or the first of September.

The first, or "dormant," spray is made with a lime-sulphur solution, during a period of calm weather soon after the snow disappears from the ground. Commercial lime-sulphur is usually used for the "dormant" spray with a 1 to 10 solution; i. e., 1 part of lime-sulphur to 9 parts of water. It is usually made from March 10 to April 10; the greater part of the work, however, is done from March 20 to April 10, at which time the leaf buds are beginning to burst. A coarse spray is applied with Bordeaux nozzles, a pressure of 150 to 175 pounds being maintained. Some orchardists do not make the winter lime-sulphur spray each year. Of the records considered, 81 made this an annual practice, while 6 used this spray every other year. A crew of 3 men and 2 horses is most commonly used, although there were a few 1-man and 2-horse, 2-men and 1-horse, and 2-men and 2-horse crews. A crew of 3 men and 2 horses will spray 3.51 acres in 10 hours, applying 6.1 gallons per tree, or 491.1 gallons per acre. (See Tables XIII, XIV, XV, XVI, and XVII.)

TABLE XIII.—*Acres sprayed in 10 hours and amount of material applied per tree by a 3-man and 2-horse crew.*

Item.	Material.			
	Lime-sulphur.	First lead-arsenate.	Second lead-arsenate.	Third lead-arsenate.
Acres per 10 hours	3.51	3.35	3.59	3.64
Gallons per tree	6.1	6.7	6.2	5.9

The first codling-moth, or lead-arsenate, spray is applied when 75 to 90 per cent of the petals have fallen. All orchardists make this spray. A fine spray is used and a pressure of from 180 to 250 pounds is maintained. It is the purpose to force this spray well into the calyx for future protection of the apple against the work of the

codling-moth larva. A crew of 3 men and 2 horses will spray 3.35 acres in 10 hours, applying 6.7 gallons per tree, or 539 gallons per acre.

The second codling-moth spray is usually applied from May 20 to June 1. The Bordeaux or Vermorel nozzles are used with a fine spray, and a pressure of from 150 to 175 pounds is maintained. It is the purpose of this spray to cover the small apples with material for protection against the first brood of codling-moth larva, which begins to appear at this time. A crew of 3 men and 2 horses will spray on the average 3.59 acres in 10 hours, applying 6.2 gallons per tree, or 505 gallons per acre.

The third codling-moth spray is usually applied from July 20 to July 31. The Bordeaux or the Vermorel nozzle is used with a fine spray, and a pressure of from 150 to 175 pounds is maintained. It is the purpose of this spray to cover the apples with material for protection against the codling-moth larva. The second brood of larva is usually hatching at this time. A crew of 3 men and 2 horses will spray 3.64 acres in 10 hours, applying 5.9 gallons per tree, or 478 gallons per acre.

TABLE XIV.—*Labor and material costs per acre for spraying where a crew of 3 men and 2 horses is used.*

Kind of spray.	Number of growers.	Per acre.			Gallons.			Material cost per acre.
		Man-hours.	Horse-hours.	Labor cost.	Per day.	Per acre.	Per tree.	
Lime-sulphur [1]	69	8.79	5.86	$3.08	1,734	494	6.1	$8.89
First lead-arsenate [2]	76	8.95	5.97	3.13	1,804	539	6.7	2.15
Second lead-arsenate	55	8.34	5.56	2.92	1,812	505	6.2	2.02
Third lead-arsenate	44	8.24	5.49	2.88	1,740	478	5.9	1.91
Fourth lead-arsenate	3	9.66	6.44	3.38	1,743	561	6.9	2.24

[1] Lime-sulphur, strength 1 to 10.
[2] Lead-arsenate, strength 2 pounds to 50 gallons of water.

There are a few orchardists who make a fourth lead-arsenate spray the latter part of August or the first of September.

Lead-arsenate is used with a strength of 1½ to 2 pounds of material to 50 gallons of water in all codling-moth sprays.

Of the 85 records considered in spraying, 84 made the "dormant" lime-sulphur spray; 22 made only the first codling-moth spray; 22 made only the first and second codling-moth sprays; 37 made the first, second, and third codling-moth sprays; 4 made the first, second, third, and fourth codling-moth sprays. In all sprays considered, there was an average of 81 trees per acre, with an average age of 11.5 years.

TABLE XV.—*Labor costs per acre for spraying, all records, regardless of crew used.*

Kind of spray.	Number of growers.	Number making spray.	Cost.		
			Per acre.	Per tree.	Per box.
Lime-sulphur	85	84	$2.84	.....	.....
First lead-arsenate	85	85	3.07	.....	.....
Second lead-arsenate	85	63	2.12	.....	.....
Third lead-arsenate	85	50	1.68	.....	.....
Fourth lead-arsenate	85	4	.15	.....	.....
Cost when all sprays are used	.....	.....	9.86	$0.1217	$0.0166

Numerous factors influence the cost of spraying. The variety and size of trees and their distance apart, the character and the contour of the land on which the spraying is done, the convenience of facilities, the purpose of the spray, condition and kind of material used, the thoroughness of the work, and whether the trees are dormant, partly or wholly in foliage, all have their bearing on the time required for the spraying operation. The average cost for spraying where all records are considered is $13.15 per acre for material and $9.86 for labor, or a total of $23.01 per acre. (See Tables XVI and XVII.)

TABLE XVI.—*Material costs per acre for spraying, all records.*

Kind of spray.	Number of ranchers.	Number making spray.	Gallons material per acre.	Cost.		
				Per acre.	Per tree.	Per box.
Lime-sulphur	85	84	467	$8.41	.....	.....
First lead-arsenate	85	85	523	2.09	.....	.....
Second lead-arsenate	85	63	362	1.45	.....	.....
Third lead-arsenate	85	50	275	1.10	.....	.....
Fourth lead-arsenate	85	4	25	.10	.....	.....
Cost when all sprays are used	.....	.....	.....	13.15	$0.1623	$0.0222

TABLE XVII.—*Total cost per acre of labor and materials for spraying all orchards.*

Kind of spray.	Number of growers spraying.	Total cost.	Cost per acre.		Total cost per tree.	Total cost per box.
			Labor.	Material.		
Lime-sulphur	84	$11.25	$2.84	$8.41	.....	.....
First lead-arsenate	85	5.16	3.07	2.09	.....	.....
Second lead-arsenate	63	3.57	2.12	1.45	.....	.....
Third lead-arsenate	50	2.78	1.68	1.10	.....	.....
Fourth lead-arsenate	4	.25	.15	.10	.....	.....
Average cost for spraying	.....	23.01	9.86	13.15	$0.284	$0.0388

MISCELLANEOUS LABOR.

There are many items of labor which in themselves do not appear to amount to a great deal, but in the aggregate take considerable time and make a cost which is recognized by many ranchers. Allowing these smaller needs or demands of the ranch to go unheeded for too long a period may later mean much expense of labor and money.

The principal items considered under this head are painting wounds where large limbs are removed from the trees, removing water sprouts, cleaning irrigation lateral ditches, and hoeing around the trees. These, together with a few others, make a miscellaneous labor charge per acre of 9.06 man-hours, or a cost of $2.27. (Table XVIII.)

TABLE XVIII.—*Labor and cost chargeable per acre prior to harvest on orchards under clean cultural management (57 ranches).*

Operation.	Hours per acre.		Cost per acre.			Cost per box.
	Man.	Horse.	Man.	Horse.	Total.	
Cultivation	28.52	50.82	$7.13	$7.62	$14.75	.....
Irrigation	34.37	.....	8.59	.....	8.59	.....
Manuring	4.32	7.92	1.08	1.19	2.27	.....
Pruning	40.31	.....	10.08	.....	10.08	.....
Hauling brush	11.86	14.46	2.97	2.17	5.14	.....
Propping	19.01	10.73	4.75	1.61	6.36	.....
Thinning	53.29	.....	13.32	.....	13.32	.....
Spraying (lime-sulphur)	8.13	5.42	2.03	.81	2.84	.....
Spraying (lead-arsenate)	19.99	13.45	5.00	2.02	7.02	.....
Miscellaneous	9.06	.....	2.27	.....	2.27	.....
Total	228.86	102.80	57.22	15.42	72.64	$0.1225

MULCH CROPS.

At the time these studies were made there was an increasing tendency to put down the orchards to alfalfa or some other legume. An indication of the cost of operation on 30 ranches under this management is given here.

Most alfalfa orchardists begin the cultural work on their orchards by a thorough use of the disk harrow as early in the spring as soil conditions permit. It is the purpose of this disking to split and spread the crowns of the plants, thus causing them to stool and send out new plants. The spike-tooth or the spring-tooth harrow and the float are used following the disk harrow, to fine and level the soil, making it more fit for plant growth and bringing it into shape for irrigation. Following this cultivation, furrows, or creases, are made for irrigation with a shovel plow or 6-foot cultivator. A few of the men plowed the alfalfa under once in three or four years and then reseeded it, but this is the exception. (See Table XIX.)

TABLE XIX.—*Man and horse hours chargeable per acre for cultivation in alfalfa orchards.*

Number of records.	Plowing.		Disking.		Cultivating.		Furrowing.		Total.	
	Man.	Horse.	Man.	Horse.	Man.	Horse.	Man.	Horse.	Man.	Horse.
30	*Hours.* 1.03	*Hours.* 2.06	*Hours.* 5.65	*Hours.* 10.86	*Hours.* 2.97	*Hours.* 5.16	*Hours.* 2.09	*Hours.* 3.39	*Hours.* 11.74	*Hours.* 21.47

Many times, in order to facilitate irrigation, it is necessary to do other labor in the orchard, such as hand hoeing and locating the work of gophers. Such items were taken into account under miscellaneous labor. Five irrigations, on an average, were made in alfalfa orchards. Alfalfa orchards required more water than the clean-cultivated orchards; nevertheless, the average time per acre for labor connected with irrigation was not much more than in the clean-cultivated orchards.

Twenty of the orchards under alfalfa management were mown, on an average, twice. (See Table XX.)

TABLE XX.—*Man and horse hours chargeable per acre for harvesting alfalfa.*

Number of records.	Mowing.		Rake and pile.		Hauling in.		Total.		Yield per acre.
	Man.	Horse.	Man.	Horse.	Man.	Horse.	Man.	Horse.	
20	*Hours.* 6.62	*Hours.* 3.13	*Hours.* 4.64	*Hours.* 0.96	*Hours.* 5.38	*Hours.* 5.58	*Hours.* 16.64	*Hours.* 9.67	*Hours.* 1.01

The figures secured indicate a cost of $11.77 per acre for cultivation and harvesting of the alfalfa crop. The total cost per acre for cultivation in orchards under clean-cultivation management was $14.75, giving a difference of $2.98 in favor of the orchards under alfalfa management. There is, however, in alfalfa orchards a cost of $8.92 per acre for irrigation, or $0.33 more than the average cost per acre for the same under clean-culture management, which would, therefore, make the difference of only $2.65 in favor of the latter. But considering the yield of 1 ton per acre of alfalfa valued at $9 per ton, there would appear to be a total difference of $11.65 per acre, or practically $0.0196 per box, in favor of the orchards under alfalfa management. (See Table XXI.)

Owing to the fact that so few have been in alfalfa for any length of time and that the management of these orchards was more or less in a transitory state, it was impossible to obtain adequate complete data on this subject. A more extended investigation would be necessary to determine the relative merits of the two methods of management.

TABLE XXI.—*Labor and cost chargeable per acre prior to harvest on orchards under mulch-crop management (30 ranches).*[1]

Operation.	Hours per acre.		Cost per acre.			Cost per box.
	Man.	Horse.	Man.	Horse.	Total.	
Cultivation	11.74	21.47	$2.94	$3.22	$6.16	.....
Irrigation	35.66	.....	8.92	.....	8.92	.....
Labor on mulch crop	16.64	9.67	4.16	1.45	5.61	.....
Manuring	4.32	7.92	1.08	1.19	2.27	.....
Pruning	40.31	.....	10.08	.....	10.08	.....
Hauling brush	11.86	14.46	2.97	2.17	5.14	.....
Propping	19.01	10.73	4.75	1.61	6.36	.....
Thinning	53.29	.....	13.32	.....	13.32	.....
Spraying (lime-sulphur)	8.13	5.42	2.03	.81	2.84	.....
Spraying (lead-arsenate)	19.99	13.45	5.00	2.02	7.02	.....
Miscellaneous	9.06	.....	2.27	.....	2.27	.....
Total	230.01	83.12	57.52	12.47	69.99	$0.1029

[1] All items of labor, except cultivation, irrigation, and labor on mulch crop, are the same as under clean-cultural management. A credit of $9 is given for 1 ton of alfalfa per acre.

HANDLING THE CROP.

Handling the crop includes all harvesting labor necessary to deliver the packed box to a local association or a railway station. This labor consists of hauling apple-box shooks to the ranch, making the apple box, picking, hauling empty and full boxes to and from the orchard during harvesting, all packing-house labor, and the delivery of the packed box to the local association or the railway station. The total handling charges are about 23 per cent of the total cost of production. The various steps in the handling of the crop will be discussed in the usual order of their occurrence. All apples for shipment are packed in the standard Northwest box, the inside measurements of which are $10\frac{1}{2}$ by $11\frac{1}{2}$ by 18 inches.

HAULING SHOOKS.

In preparing for harvest the orchardist usually hauls a part or all of his box shooks to the ranch the latter part of the summer previous to the beginning of harvest. Many orchardists haul a portion of their shooks on return trips from hauling packed boxes to the shipping point during harvest time. Some buy box shooks on contract, delivered at the ranch. Others buy them and pay a stipulated price for delivery. This price of course varies with the distance the shooks are hauled. A crew of 1 man and 2 horses will haul approximately 477 box shooks a distance of 1.83 miles in two hours. The average cost per mile per shook for hauling is $0.002 and the average distance hauled is 1.79 miles. A crew of 1 man and 1 horse is sometimes used for hauling shooks, but there were not enough records of this method to give a reliable average.

BOX MAKING.

The boxes are usually made by the orchardist and members of his family if the number necessary for the crop is not too large. Where boxes are made by contract there is a charge of $0.0075 to $0.01 per box.

PICKING.

Picking is usually begun on the Jonathans about the 1st of September and ends with the Winesaps along in November. Picking is done by hand into buckets of various kinds. The galvanized one-half bushel bucket is most common, although some use a galvanized-iron bucket with a canvas bottom which may be opened to allow the

FIG. 5.—Picking Grimes Golden apples. Showing one type of ladder used for picking in the valley.

fruit to pass into a picking box without injury. The pickers ordinarily work from orchard ladders and stepladders varying in length from 8 to 10 feet. (See fig. 5.) On account of the size of the trees, it is seldom necessary to use a ladder over 14 feet in length. Some varieties are picked two or three times. Where ripening is irregular among the red varieties, orchardists pick the apple when it approaches a correct stage of ripeness and has obtained the proper color. It is not customary to pick apples by contract per box. All picking is done by day labor at from $2.25 to $2.50 per 10-hour day. The apples when picked are placed in packing boxes which previously have been scattered at convenient places throughout the orchard. The average picker will pick from 50 to 80 loose boxes per day. The average for all records was 74.6 loose boxes, or 49.73 packed boxes, per 10-hour day, at a cost of $0.0503 per packed box.

HAULING APPLES TO PACKING SHED.

Prior to and during the picking season empty boxes are hauled and scattered at convenient places for the pickers throughout the orchard. The boxes in which the apples are placed to be hauled to the packing shed are the same or similar to the ones in which the apples are packed. A wagon or sled with one or two horses is used in hauling the boxes to and from the orchards. A crew of 1 man and 1 or 2 horses is generally used for hauling the apples. (See Table XXII.)

TABLE XXII.—*Cost of hauling to packing house under different methods.*

A.—SLED.

Number of—		Hours per load.	Loose boxes per load.	Cost per packed box.
Men.	Horses.			
1	2	0.54	30.2	$0.0147
1	1	.403	15.6	.0155

B.—WAGON.

1	2	0.745	42.2	$0.0146
1	1	.675	29.5	.0137

Regardless of crew with wagon or sled, the cost per packed box of hauling boxes to and from the orchard is $0.0144.

PACKING.

All apples are usually packed in a packing house, a barn, or a shed ordinarily used for other purposes. (See fig. 6.) But little sorting, grading, and packing is done in the orchard. All fruit is packed as soon as possible after it is picked. An occasional grower may store a few of the late varieties in a cool place and pack them during the winter.

The size of the crew employed in the packing is usually governed by the size of the crop. As most of the orchards are small, much of the work is done by the orchardist and members of his family. Where the orchards and crops are large it is necessary to employ several sorters and packers, with the necessary additional help. In the larger packing houses there are usually employed men whose duty it is to supply the packers and sorters with boxes, paper, and fruit, and to carry away the packed boxes. These "waiters" deliver the fruit to a man, who nails and stamps the box. Where there are a small number of packers and sorters one man may wait on the packers and do the nailing.

All fruit is sorted; sometimes by the men as they pack, sometimes by a person especially employed for this purpose. The sorters usually sort the fruit from the loose boxes into three grades: Extra Fancy, Fancy, and Choice. The culls are thrown into boxes close at hand. In some instances the fruit is placed on canvas packing tables and sorted in a similar manner. Some of the growers who harvest the largest crops use mechanical sizers, but when this investigation was made so few men had adopted this method of sizing that it was impossible to obtain enough data to give reliable averages. Both men and women are employed in sorting and packing. One person will sort from 50 to 100 boxes per day. The sorters are paid $0.225 to $0.25 per hour for labor.

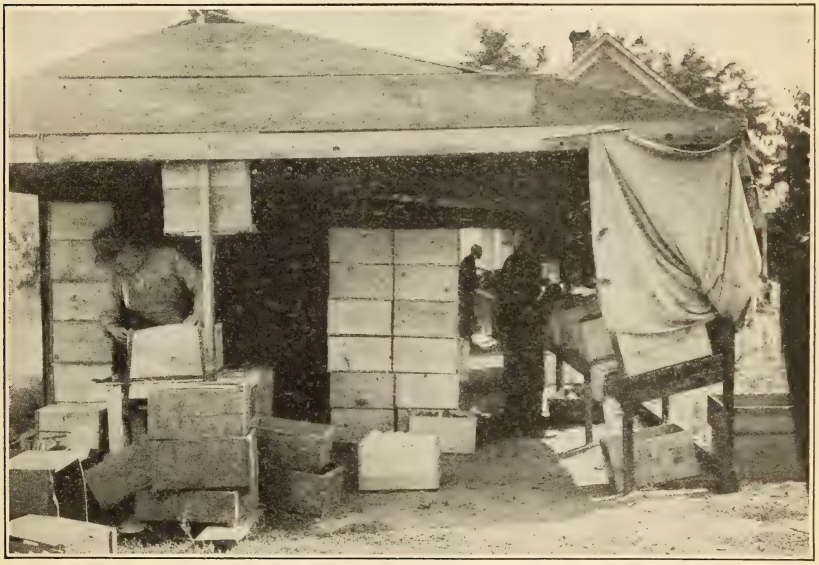


FIG. 6.—Packing apples in the Wenatchee Valley. This type of packing shed is not uncommon on many of the smaller ranches.

It is the usual practice to line all boxes with paper before packing. All grades of apples are wrapped. As previously stated, the packer may both sort and pack, or may merely pack sorted fruit. Over 64 per cent of the growers practice the former method. A man will sort and pack 69 boxes in 10 hours, whereas a man who packs sorted fruit will average 76 boxes in the same time. The former receives $0.07 per box, while the latter receives $0.06. Three loose boxes, as they come from the orchard, usually pack out two boxes. The cost of each operation or combination of operations in handling the fruit has been distributed over all records, so that the resulting cost per box is an average for all ranches. (See Table XXIII.)

TABLE XXIII.—*Items considered in figuring packing-house charge (87 ranches).*

Operation.	Cost per box.	Operation.	Cost per box.
Sorting and packing	$0.07	Sorting	$0.0278
Packing sorted fruit	.06	Stamping and nailing	.0083
Nailing and "waiting"	.0166	Foremen's supervision	.0030

The average packing-house charge, figured from the above averages, was $0.087 per packed box.

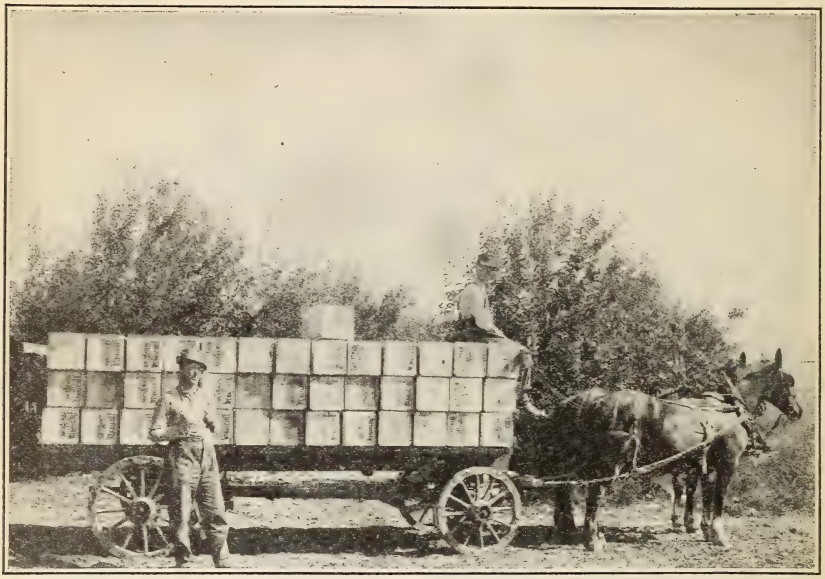


FIG. 7.—Hauling apples to station. There are 118 boxes in this load. The average load hauled with a 1-man and 2-horse crew is 89.69 boxes.

HAULING PACKED BOXES.

During harvesting the apples are usually delivered to a local association or a shipping point. The majority of growers do their own hauling. Eighty-one followed this practice, 68 with a crew of 1 man and 2 horses, and 13 with a 1-man and 1-horse crew. The load varies from 70 to 130 boxes with the former and from 30 to 70 boxes with the latter. (See fig. 7.) Four of the growers contracted to have their apples hauled, the price per box varying from $0.01 to $0.03 with the distance. Two loaded their apples directly on cars, a railroad siding being close at hand. The crew doing the hauling was governed to some extent by the distance to the point of delivery. (See Table XXIV.)

TABLE XXIV.—*Hauling to shipping point—Average distance and time and boxes per load for each crew.*

Number of records.	Number of—		Miles.	Hours per load.	Boxes per load.
	Men.	Horses.			
68	1	2	1.78	2.37	89.69
13	1	1	1.32	1.42	46.53

Where all records were considered, the average cost for hauling per mile per packed box was $0.0082.

CULLS.

A problem worthy of much consideration by the growers of the valley is that of the disposition of apples which are not packed for market.

As in many other apple-producing regions, growers do not believe that the money received for the cull fruit pays them for the handling. This requires, in many regions, the picking of culls from the ground. There are, however, many apples which are culled in the packing house during sorting and packing.

The handling of this grade of apples has been adversely affected in more ways than one. In a short-crop year when prices are good the growers do not feel the necessity of handling the culls for the prices which the owners of the by-product plants will pay. In years of low prices, which are generally years of large crops, the by-product company usually is not able to handle the whole cull crop of a district. This condition has been unfavorable to the development of the by-product industry. No doubt there are many other factors which are equally important in discouraging its advancement. In this study no account has been taken of the cull apples, since at the time when the survey was made there was no important by-product plant in the valley.

Wayne County, N. Y., produces very large quantities of dried apples. Many of the farms there are small, but it is not uncommon for the orchardist to own and manage his own drier plant in connection with his regular farm business. Some orchardists who do not have enough drier stock of their own find it easy to buy sufficient quantities at reasonable prices from their neighbors. The initial investment is not great. Such a plan might prove of interest and value to the growers of Wenatchee Valley.

LABOR COSTS.

The total labor cost in clean cultivated orchards was $179.09 per acre, or $0.3020 per box. The labor cost prior to harvesting

amounted to $72.64 per acre, or $0.1225 per box. This cost was approximately 40 per cent of the total labor cost. Table XVIII gives the summary of the various items which make up the total labor chargeable per acre prior to harvesting in orchards under clean cultural management.

TABLE XXV.—*Labor cost for harvesting (87 ranches).*

Item.	Hours per acre.		Cost per acre.	Cost per box.
	Man.	Horse.		
Hauling shooks (average distance hauled 1.79 miles)	3.81	7.18	$2.04	$0.0034
Making boxes	17.8		4.45	.0075
Hauling empties to and from orchard	17.95	26.90	8.52	.0144
Hauling full boxes (average distance 1.70 miles)	15.96	28.46	8.26	.0139
Foreman charge [1]			1.78	.0030
Picking	119.24		29.81	.0503
Sorting, packing, stamping, and nailing			51.59	.0870
Total	174.76		106.45	.1795

[1] Twenty records:

Average crew	5
Average number of days per acre for harvesting crop	11.9
Foreman days per acre	2.38
Foreman wage per day	$3.25
Cost per acre	$7.75

Twenty-three per cent of records use foreman; 23 per cent × $7.75 = $1.783.

Foreman charge per acre	$1.78

The labor cost for harvesting amounted to $106.45 per acre, or $0.1795 per box. This cost was approximately 60 per cent of the total labor cost. Table XXV gives the summary of the various items which make up the total labor cost for harvesting. Table XXVI gives the total annual labor cost per acre, per box, and per tree.

TABLE XXVI.—*Total labor cost per acre, per box, and per tree (87 ranches).*

Item.	Total labor cost.		
	Per acre.	Per box.	Per tree.
Labor before harvest [1]	$ 72.64	$0.1225	$0.8968
Labor before harvest [2]	60.99	.1028	.7406
Harvesting labor	106.45	.1795	1.314
Total labor (clean culture)	179.09	.3020	2.211
Total labor (alfalfa)	167.44	.2823	2.067

[1] Labor before harvest where only clean cultivated orchards are considered.
[2] Labor before harvest where only alfalfa orchards are considered; credit is given for 1 ton of alfalfa per acre at $9 per ton.

MATERIAL COSTS.

Material costs include all material such as box shooks, nails, etc., together with anything else for which cash, or its equivalent, must be used. A manure charge was made against the entire orchard for the amount applied each year, whether on a part or the whole of the orchard.

Labels are put on the boxes of the extra fancy and fancy grades. No accurate information as to the percentage of extra fancy and fancy fruit was obtained. The growers estimated approximately 70 per cent. The price of high-grade labels does not vary much if purchased in large lots. In some instances the fruit is labeled before delivery to an association or shipping point. When the labels are furnished and applied by the association, a charge of 1 cent per box is usually made. The label cost as a whole appears under material costs, for it was difficult to determine the time required for labeling. Other material costs are shown in Table XXVII. These costs are $103.71 per acre, amounting to $0.1749 per box, or 22.40 per cent of the total box costs.

TABLE XXVII.—*Material costs in 1914 (87 ranches).*

Item.	Cost per acre.	Cost per box.
Box shooks	$62.27	$0.1050
Nails	1.48	.0025
Paper	16.82	.0284
Labels[1]	5.93	.01
Lime-sulphur	8.41	.0142
Lead-arsenate	4.74	.0080
Manure	3.46	.0058
Gasoline and oil	.60	.0010
Total	103.71	.1749

[1] Includes putting on of the labels.

FIXED COSTS.

The term "fixed costs" includes all costs other than labor and material costs that enter into and make up the total cost of production. Under this heading come such items as taxes, insurance, and machinery depreciation. These fixed costs are shown in Table XXVIII. The tax and insurance charges per acre, other than water tax, on the bearing apple orchard are found by prorating the total tax and insurance on the entire ranch in the proportion that the apple orchard is of the total investment.

The water tax of $1.69 per acre is the average of the rates in force on the various ditches, ranging from $1.50 to $3.50 per acre. This rate varies from year to year, depending upon the ditch.

The interest on investment is figured at the prevailing rate (8 per cent) on the estimated value of the bearing apple orchard land as given by the rancher at the time this investigation was made.

The charge for use of equipment is computed by considering the interest 8 per cent, depreciation 11 per cent, taxes 1 per cent, and repairs 5 per cent, which amounts to an annual charge of 25 per cent on the total equipment investment.

The charge for the use of the packing house is computed by considering the interest at 8 per cent, depreciation at 3 per cent, taxes 1 per cent, and repairs 3 per cent, which amounts to 15 per cent on the total packing-house investment.

No account has been taken of the depreciation of the orchards themselves, as the average length of life of the commercial varieties under the methods of management in vogue here is not known. However, in arriving at the true cost of apple production such a charge should be considered.

TABLE XXVIII.—*Fixed costs, 87 orchards.*

Item.	Cost per acre.	Cost per box.
Taxes	$13.08	$0.0221
Water tax	1.69	.0028
Insurance	.96	.0016
Interest on investment	154.00	.2597
Equipment charge	10.42	.0176
Packing house building charge	6.78	.0114
Total	186.93	.3152

The various annual costs of producing apples in the bearing orchards studied in Wenatchee Valley, including delivery at shipping point, are summarized in Table XXIX. The fixed, or overhead, cost is 40 per cent, while the labor and material costs are respectively 38 and 22 per cent of the total cost of production.

TABLE XXIX.—*Summary of labor, cash, and fixed costs per acre (clean-cultivated orchards).*

Items of cost.	Total cost.			Per cent of total cost.
	Per acre.	Per box.	Per tree.	
Labor	$179.09	$0.3020	$2.211	38.13
Material	103.71	.1749	1.280	22.08
Fixed cost	186.93	.3152	2.308	39.79
Total	469.73	.7921	5.799	100.00

The largest single charge that enters into these totals is that of interest on investment, which is 33 per cent of the total. This leaves about 67 per cent for all other costs, so that in considering only those expenses which the average rancher usually would calculate, the production of a box of apples is shown to cost on the farms studied in the valley about 50 cents.

Considering costs in that way, however, gives a misleading figure, for the calculation leaves out not only several items, but the largest

single item, that of interest on investment, which in the case of the farms studied is nearly 26 cents per box. When this and other charges are considered it is found that the average cost of producing apples on the farms studied in the Wenatchee Valley having bearing orchards under clean cultural management in 1914 was $0.7921 per box. In orchards under mulch-crop management the cost is approximately $0.02 per box less.

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